

METHOD OF FABRICATING FLUID FLOW FIELD PLATES

Field of the Invention

[0001] The present invention relates to electrochemical fuel cells. More particularly, the present invention relates to fluid flow field
5 plates and to a method of fabricating such plates.

Background of the Invention

[0002] Electrochemical fuel cell assemblies
10 convert reactants, namely fuel and oxidant, to generate electric power and reaction products. Electrochemical fuel cell assemblies generally employ an electrolyte disposed between two electrodes, namely a cathode and an anode. The
15 electrodes generally each comprise a porous, electrically conductive sheet material and an electrocatalyst disposed at the interface between the electrolyte and the electrode layers to induce the desired electrochemical reactions.
20 The location of the electrocatalyst generally defines the electrochemically active area.

[0003] Solid polymer fuel cell assemblies typically employ a membrane electrode assembly ("MEA") consisting of a solid polymer
25 electrolyte, or ion exchange membrane, disposed between two electrode layers. The membrane, in addition to being ion conductive (typically

proton conductive) material, also acts as a barrier for isolating the reactant (that is, fuel and oxidant) streams from each other.

[0004] The MEA is typically interposed between
5 two separator plates, which are substantially impermeable to the reactant fluid streams, to form a fuel cell assembly. The plates act as current collectors, provide support for the adjacent electrodes, and typically contain fluid
10 flow field channels for supplying reactants to the MEA or for circulating coolant. The plates are typically referred to as fluid flow field plates. The fuel cell assembly is typically compressed to promote effective electrical
15 contact between the plates and the electrodes, as well as effective sealing between fuel cell components. A plurality of fuel cell assemblies may be combined electrically, in series or in parallel, to form a fuel cell stack. In a fuel
20 cell stack, a plate can be shared between two adjacent fuel cell assemblies, in which case the plate also separates the fluid streams of the two adjacent fuel cell assemblies. Such plates are commonly referred to as bipolar plates and may
25 have flow channels formed therein for directing fuel and oxidant, or a reactant and coolant, on each major surface, respectively.

[0005] The fuel stream that is supplied to the anode typically comprises hydrogen. For example,
30 the fuel stream may be a gas such as

substantially pure hydrogen or a reformat stream containing hydrogen. Alternatively, a liquid fuel stream such as aqueous methanol may be employed.

5 [0006] The oxidant stream, which is supplied to the cathode, typically comprises oxygen, such as substantially pure oxygen or a dilute oxygen stream such as air.

[0007] The electrochemical reactions in a
10 solid polymer fuel cell are generally exothermic. Accordingly, a coolant is typically also employed to control the temperature within a fuel cell assembly. Conventional fuel cells employ a liquid, such as, for example, water, to act as a
15 coolant. In conventional fuel cells, the coolant stream is fluidly isolated from the reactant streams.

[0008] Fluid isolation is important for several reasons. For example, one reason for
20 fluidly isolating the fuel and oxidant streams in a hydrogen-oxygen fuel cell is the reactivity of hydrogen and oxygen with each other. The MEA and separator plates are, therefore, substantially impermeable to hydrogen and oxygen. However,
25 since the MEA also functions as an electrolyte, the membrane is generally permeable to protons and water (water is generally required for proton transport in membrane electrolytes).

[0009] Fluid flow field plates are generally
30 formed from a suitable electrically conductive

material. Furthermore, as indicated above, fluid
flow field plates are typically made of a
substantially fluid impermeable material (that
is, a material sufficiently impervious to typical
5 fuel cell reactants and coolants to fluidly
isolate the fuel, oxidant and coolant fluid
streams from each other). Expanded graphite,
also known as flexible graphite, is a material
that is employed in the manufacture of fluid flow
10 field plates. Furthermore, because expanded
graphite is a compressible material, an embossing
process, such as roller embossing or reciprocal
(also know as stamp) embossing, may be employed.

[0010] When compared with conventional
15 engraving or milling methods, embossing processes
typically provide cost and speed advantages.
Embossing processes also typically minimize part
handling, thereby making them better suited for
mass production. Conventional embossing
20 processes, more specifically reciprocal embossing
and roller embossing, present different relative
shortcomings with respect to one another.

[0011] Improved tolerances are typically
achieved by reciprocal embossing. Indeed, the
25 raw material fed into a reciprocal embossing
apparatus (typically in the form of discrete
sheets) can typically be thicker than the raw
material fed into a roller embossing apparatus
(typically in the form of rolled sheet material).
30 The ability to work with a thicker piece of

material generally results in improved accuracy, including achievement of dimensional tolerances and repeatability, in the mass fabrication of fluid flow field plates. In the production of
5 elongated fluid flow field plates, however, which typically comprise substantially straight (that is, linearly extending), parallel channels extending between fluid distribution regions located at opposite ends of each fluid flow field
10 plate (also referred to as header regions), the thickness of such an elongated plate as well as the parallelism of its channels over the plate's entire length are more easily controlled by roller embossing.

15 **[0012]** On the other hand, reciprocal embossing is typically a slower and more expensive process than roller embossing. Indeed, reciprocal embossing typically involves higher tonnage equipment than roller embossing. Reciprocal
20 embossing typically includes a pre-stamping requirement for removing air from the material to be embossed; such a pre-stamping requirement is typically not associated with roller embossing. Roller embossing also typically allows continuous
25 processing of material to and/or from the equipment involved, and allows for continuous cleaning of embossing teeth; conversely, reciprocal embossing typically requires temporary interruptions of the processing of material to
30 and/or from the equipment involved, both to allow

for embossing and to allow for the cleaning of embossing teeth.

[0013] In light of the foregoing, roller embossing has at times been the preferred
5 embossing process for the mass production of fluid flow field plates, especially the mass production of elongated fluid flow field plates. However, the roller embossing process does suffer from particular shortcomings.

10 [0014] Expanded graphite material with a suitable degree of flowability is typically used during a roller embossing process. As the expanded graphite material is extruded from the rolling dies, however, variations in plate length
15 typically result. In order to account for the anticipated extrusion, difficult and expensive adjustments often need to be implemented. The expanded graphite material would typically be post-impregnated (that is, the material is
20 impregnated after it has been embossed) with a curable polymeric composition or material (such as methacrylate), and then cured by conventional means (such as heating or radiation) in order to, among other things, improve the plates'
25 mechanical characteristics. A pre-impregnated material (that is, the material is impregnated before it has been embossed) is typically not employed because of the resultant increase in the number of variables that can detrimentally affect
30 anticipated extrusion. Indeed, employing a pre-

impregnated material, as opposed to a post-impregnated material, would typically increase the difficulty and expense of the adjustments needed to account for the anticipated extrusion.

5 [0015] For example, with respect to elongated fluid flow field plates that include substantially straight, parallel channels extending between fluid distribution regions located at opposite ends of each fluid flow field
10 plate, the rolling dies include embossing teeth, which emboss the channels, and special inserts, which are incorporated into the rolling dies to form the fluid distribution regions. The position of the special inserts on the rolling
15 dies need typically to be pre-corrected to account for the anticipated extrusion. As the anticipated extrusion may vary between batches of raw material fed into the roller embossing apparatus, the pre-correction step can result in
20 a process that is difficult and expensive to implement, as the inserts may need to be removed and re-positioned a number of times on the surface of the rolling dies during production.

[0016] Another shortcoming of conventional
25 roller embossing techniques is the introduction of residual stresses in certain areas of the fluid flow field plates, more specifically around transitional areas where the fluid flow field plates changes from one cross-sectional profile
30 to another.

[0017] For example, with respect to elongated fluid flow field plates comprising substantially straight, parallel channels extending between fluid distribution regions located at opposite
5 ends of each fluid flow field plate, residual stresses are typically introduced around areas of transition between the fluid flow field channels and the fluid distribution regions. These residual stresses often result in warping and/or
10 breaking of the fluid flow field plates around such transitional regions, thereby leading to higher than desired rejections for a mass production process.

[0018] Accordingly, there is a general need
15 for a method of mass production of fluid flow field plates that addresses the above-noted shortcomings. The present method overcomes such shortcomings, and provides further related advantages.

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Summary of the Invention

[0019] A method of fabricating a fluid flow field plate, which is suitable for use in an electrochemical fuel cell assembly, comprises (a)
25 roller embossing a first embossed pattern in a sheet of compressible, electrically conductive material, and then (b) reciprocal embossing a second embossed pattern in the sheet.

[0020] The first embossed pattern can comprise
30 a fluid flow field channel region. In one

embodiment, the first embossed pattern comprises fluid flow field channels, more specifically substantially straight, parallel fluid flow field channels.

5 [0021] The second embossed pattern can comprise a fluid distribution region. In one embodiment, the second embossed pattern comprises manifold openings and supply channels.

[0022] The sheet material can be pre-
10 impregnated with a curable polymeric composition, with the method further comprising a step of curing the pre-impregnated sheet material. Pursuant to the present method, the curing step is performed after the roller embossing and the
15 reciprocal embossing steps. In one embodiment, the sheet material is pre-impregnated with expanded graphite.

[0023] The reciprocal embossing step can comprise simultaneously reciprocally embossing a
20 first fluid distribution region of one fluid flow field plate and a second fluid distribution region of another fluid flow field plate. In one embodiment, the reciprocal embossing step comprises simultaneously reciprocally embossing a
25 first set of manifold openings and supply channels of one fluid flow field plate and a second set of manifold openings and supply channels of another fluid flow field plate.

[0024] The reciprocal embossing step can
30 further comprise cutting the sheet between the

first fluid distribution region of the one fluid flow field plate and the second fluid distribution region of the other fluid flow field plate.

5 [0025] The reciprocal embossing step can be performed at preset length intervals of the roller embossed sheet material, the preset length equal to the desired length of the fluid flow field plate.

10 [0026] Specific details of certain embodiment(s) of the present method are set forth in the detailed description below to provide an understanding of such embodiment(s). Persons skilled in the technology involved here will
15 understand, however, that the present method has additional embodiments, and/or may be practiced without at least some of the details set forth in the following description of preferred embodiment(s).

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Brief Description of the Drawings

[0027] Figure 1A is a cross-sectional view of a solid polymer fuel cell assembly.

[0028] Figure 1B is a cross-sectional view of
25 the fluid flow field plates of the fuel cell assembly of Figure 1A.

[0029] Figure 2A shows a top view and a side view of a schematic representation of a fluid flow field plate that can be fabricated pursuant
30 to the present method.

[0030] Figures 2B, 2C and 2D are more detailed views of the fluid flow field plate of Figure 2A.

[0031] Figure 3A is a perspective view of a schematic representation of a fluid flow field plate being fabricated pursuant to a roller embossing step of an embodiment of the present method.

[0032] Figure 3B is a section view along lines 3B-3B of Figure 3A.

10 [0033] Figures 4A, 4B and 4C are schematic representations of a fluid flow field plate being fabricated pursuant to a reciprocal step of an embodiment of the present method.

[0034] Figures 5A, 5B and 5C are plan views of 15 further fluid flow field plates that can be fabricated pursuant to the present method.

[0035] Figure 6 is a plan view of a further fluid flow field plate that can be fabricated pursuant to the present method.

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Detailed Description of Preferred Embodiment(s)

[0036] The following paragraphs describe embodiment(s) of the present method of fabricating fluid flow field plates that are 25 suitable for use in electrochemical fuel cell assemblies.

[0037] Figure 1A illustrates a partial cross-sectional view of a solid polymer fuel cell assembly. MEA 5 comprises a cathode 2, an anode 30 4 and a solid electrolyte 3 interposed there-

between. MEA 5 is interposed between a fuel flow field plate 1 and an oxidant flow field plate 6. Oxidant stream is supplied to cathode 2 via a number of oxidant channels 62 (in oxidant flow field plate 6), with oxidant channel lands 61 interposed therebetween. Fuel stream is supplied to anode 4 via fuel channels 22 (in fuel flow field plate 1), with fuel channel lands 21 interposed there-between. Coolant stream flows through coolant channels 26 (in fuel flow field plate 1), with coolant channel lands 27 interposed there-between. Whereas open-faced oxidant channels 62 and fuel channels 22 fit against MEA 5 to form complete channels, coolant channels 26 typically fit against a non-active surface 67 of an adjacent oxidant flow field plate to form complete channels. Figure 1B, which will be referred to below, illustrates a partial cross-sectional view of fuel flow field plate 1 and oxidant flow field plate 6.

[0038] Figures 2A, 2B, 2C and 2D are various views of fuel flow field plate 1. Figure 2A shows a top view and a side view of a schematic representation of fuel flow field plate 1. Figure 2B is a more detailed plan view of fuel flow field plate 1, with fuel flow field channels 22 facing upwards. Figure 2C is a more detailed side view of fuel flow field plate 1. Figure 2D is a more detailed plan view of fuel flow field

plate 1, with coolant flow field channels 26 facing upwards.

[0039] As shown in Figure 2A, fuel flow field plate 1 is schematically divided into three regions: a leading fluid distribution region, in the embodiment shown as leading header region 10, a fluid flow field channel region 20 and a trailing fluid distribution region, in the embodiment shown as trailing header region 30.

10 Leading header region 10 of fuel flow field plate 1 has a length L_{10} , a width W_{10} and a thickness T_{10} . Trailing header region 30 of fuel flow field plate 1 has a length L_{30} , width W_{30} and a thickness T_{30} . Fuel flow field channel region 20 of fuel

15 flow field plate 1 has a length L_{20} , width W_{20} and a thickness T_{20} . Consequently, fuel flow field plate 1 has a total length L (equal to $L_{10} + L_{20} + L_{30}$). Length L_{10} and length L_{30} are typically approximately equal. Each of leading header

20 region width W_{10} and trailing header region width W_{30} typically do not exceed width W_{20} . More specifically, and as shown in Figure 2A, width parameters W_{10} , W_{20} and W_{30} are typically approximately equal. Each of leading header

25 region thickness T_{10} and trailing header region thickness T_{30} typically do not exceed thickness T_{20} . More specifically, and as shown in Figure 2A, thickness parameters T_{10} , T_{20} and T_{30} are typically approximately equal.

[0040] As shown in Figure 2B (which is a top view of fuel flow field plate 1, with fuel flow field channel region 20F facing upwards), fuel flow field channels 22 are substantially

5 straight, parallel to one another, and extend between leading header region 10F and trailing header region 30F. Fuel flow field channels 22 have an open width W_{22} and a pitch P_{22} (seen in more detail in Figure 1B). For a particular

10 pitch value, the greater width W_{22} , the smaller is the width W_{21} of fuel channel lands 21. A fuel stream originating from fuel inlet manifold opening 12 is directed via fuel inlet passages 13 to fuel flow field region 20F, more specifically

15 to fuel flow field channels 22; in turn, the fuel stream flows out of fuel flow field region 20F to fuel outlet manifold opening 32 via fuel outlet passages 33. Fuel inlet manifold opening 12 and fuel outlet manifold opening 32 are each fluidly

20 connected to similar manifold openings of fuel and oxidant flow field plates of adjacent fuel cell assemblies.

[0041] As shown in Figure 2D (which is a top view of fuel flow field plate 1, with fuel flow field channel region 20C facing upwards), coolant flow field channels 26 are substantially

25 straight, parallel to one another, and extend between leading header region 10C and trailing header region 30C. Coolant flow field channels

30 26 have an open width W_{26} and a pitch P_{26} (seen in

more details in Figure 1B). For a particular pitch value, the greater width W_{26} , the smaller is the width W_{27} of coolant channel lands 27. A coolant stream originating from coolant inlet manifold opening 16 is directed via coolant inlet passages 17 to coolant flow field region 20C, more specifically to coolant flow field channels 26; in turn, the coolant stream flows out of coolant flow field region 20C to coolant outlet manifold opening 36 via coolant outlet passages 37. Coolant inlet manifold opening 16 and coolant outlet manifold opening 36 are each fluidly connected to similar manifold openings of fuel and oxidant flow field plates of adjacent fuel cell assemblies.

[0042] As shown in Figures 2B and 2D, oxidant inlet manifold opening 15 and oxidant outlet manifold opening 35 allow an oxidant stream to flow to oxidant channels 62 of adjacent oxidant flow field plates 6.

[0043] Figure 2C is a schematic side view of fuel flow field plate 1, with fuel side facing upwards and coolant side facing downwards. The fuel side comprises leading header region 10F, fuel flow field region 20F and trailing header region 30F. The coolant side comprises leading header region 10C, coolant flow field region 20C and trailing header region 30C. It should be noted that, for purposes of simplicity, Figure 2C does not explicitly show manifold openings

extending through fuel flow field plate 1, but it is to be understood that such openings do extend from one surface to the other.

[0044] Pursuant to an embodiment of the present method, fluid flow field regions 20F and 20C are fabricated by roller embossing. More specifically, pursuant to an embodiment of the present method as shown in Figures 3A and 3B (Figure 3B being a section view along line 3B-3B of Figure 3A), sheet of material 40 is fed, from a roll, through a dual-roller embossing apparatus comprising a top roller 41A and a bottom roller 41B. As outlined above, post-impregnated expanded graphite is typically employed (that is, resin impregnation and curing occurring after embossing). In the present embodiment of the method, pre-impregnated expanded graphite is used (that is, resin impregnation occurs before embossing, with curing occurring after embossing). Pre-impregnation tends to give material 40 better flowability characteristics during embossing, thereby resulting in better tolerances being achieved in the fluid flow field plate. As discussed in more detail below, the resultant increase in anticipated extrusion is no longer as problematic as in prior, conventional fluid flow field plate fabrication methods.

[0045] The dual-roller embossing apparatus is adapted so as to emboss fuel flow field channel region 20 onto sheet of material 40, more

specifically so as to emboss fuel flow field
channel region 20F (which comprises fuel flow
field channels 22) on one surface and coolant
flow field channel region 20C (which comprises
5 coolant flow field channels 26) on the opposite
surface. In the present embodiment, this is
accomplished by employing rollers 41A and 41B
with embossing teeth that emboss the desired
profile in sheet 40; more specifically, roller
10 41A comprises embossing teeth 42A that emboss
fuel flow field channels 22 and roller 41B
comprises embossing teeth 42B that emboss coolant
flow field channels 26.

[0046] Because flow field plate thickness
15 parameters T_{10} and T_{30} do not exceed thickness T_{20}
(in the plate shown in Figure 2A, they are the
same) and fluid flow field plate width parameters
 W_{10} and W_{30} do not exceed width W_{20} (in the plate
shown in Figure 2A, the thicknesses are
20 approximately equal), the dual-roller embossing
apparatus is also adapted so that sheet 40 is
embossed to fluid flow field channel region 20's
required thickness T_{20} and width W_{20} .

Consequently, when sheet 40 emerges from the
25 dual-roller apparatus, it is a sheet of thickness
 T_{20} and width W_{20} , with fuel flow field channels 22
embossed on one side and coolant flow field
channels 26 embossed on another.

[0047] Pursuant to the present method, header
30 regions 10 and 30 are thereafter subsequently

reciprocally (or stamp) embossed and sheet 40 is cut at the appropriate length L (it is to be understood that intermediary step(s) can be performed between the roller and reciprocal embossing steps). More specifically, as will be outlined in more detail below and be shown in Figures 4A, 4B and 4C, a reciprocal embossing apparatus simultaneously forms leading header region 10 on one fluid flow field plate and trailing header region 30 on an adjacent fluid flow field plate. Because sheet 40 is embossed twice at certain locations (more specifically, some portions of sheet 40 are first roller embossed with fluid flow field channel region 20 and then subsequently reciprocally embossed with leading header region 10 or trailing header region 30), a material with suitable flowability characteristics, such as pre-impregnated expanded graphite, is employed. A pre-impregnated material can be employed because the present method no longer requires difficult and expensive adjustments to account for anticipated extrusion.

[0048] Because the reciprocal embossing step is performed after the roller embossing step, removal of entrapped air in the material, which is typically part of a reciprocal embossing step, is no longer necessary. Indeed, roller embossing of sheet of material 40 increases the density of the material to the point where almost no void or pockets remain. As a result, the reciprocal

embossing step does not require the additional step of removal of entrapped air. This has a positive impact on speed of the reciprocal embossing step and, consequently, on overall
5 manufacturing speed of fuel flow field plate 1.

[0049] Also, because variation in length of sheet of material 40 tends to occur during the roller embossing step, cutting sheet of material 40 to the precise desired length L after it has
10 been roller embossed, but before it has been cured, is beneficial.

[0050] A schematic representation of an embodiment of the reciprocal step of the method is shown in Figures 4A, 4B and 4C. The
15 reciprocal embossing step occurs after sheet of material 40 has been roller embossed (that is, after fluid flow field channel regions 20F and 20C have been embossed onto sheet 40 (as shown in part 1 of Figure 4A)).

[0051] As shown in part 1 of Figure 4A, the reciprocal embossing apparatus comprises reciprocal dies 52 and 152. Reciprocal die 52 comprises a cutter blade 53 and stamping surfaces 54 and 55. In the present embodiment, stamping
25 surface 54 is adapted to emboss leading header region 10F of fuel side of fuel flow field plate 1 in sheet material 40 and stamping surface 55 is adapted to emboss trailing header region 30F of fuel side of fuel flow field plate 1 in sheet
30 material 40. Cutter blade 53 is adapted to cut

sheet 40. Reciprocal die 152 comprises a recess 153 and stamping surfaces 154 and 155. In the present embodiment, stamping surface 154 is adapted to emboss leading header region 10C of coolant side of fuel flow field plate 1 in sheet material 40 and stamping surface 155 is adapted to emboss trailing header region 30C of coolant side of fuel flow field plate 1 in sheet material 40. Recess 153 is dimensioned to receive cutter blade 53. Although not explicitly shown, stamping surfaces 54 and 154 are also adapted to cut manifold openings 12, 15 and 16. Similarly, stamping surfaces 55 and 155 are adapted to cut manifold openings 32, 35 and 36.

15 [0052] As shown in part 2 of Figure 4A, reciprocal dies 52 and 152 simultaneously reciprocally emboss sheet 40. More specifically, stamping surfaces 54 and 154 simultaneously emboss fuel inlet passages 13, coolant inlet passages 17, fuel inlet manifold opening 12, oxidant inlet manifold opening 15 and coolant inlet manifold opening 16 of one fluid flow field plate (that is, leading header region 10F on one side and leading header region 10C on another

25 (see Figures 2B and 2D for details on both leading header regions)). Similarly, stamping surfaces 55 and 155 simultaneously emboss fuel outlet passages 33, coolant outlet passages 37, fuel outlet manifold opening 32, oxidant outlet manifold opening 35 and coolant outlet manifold

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opening 16 of another fluid flow field plate
(that is, trailing header region 30F on one side
and trailing header region 30C on another (see
Figures 2B and 2D for details on both trailing
5 header regions)).

[0053] As reciprocal dies 52 and 152
simultaneously stamp emboss header region 10 of
one fluid flow field plate and trailing header
region 30 of an adjacent fluid flow field plate,
10 cutter 53 cuts sheet of material 40 in between
(see part 3 of Figure 4A). As outlined above,
variation in length of sheet 40 tends to occur
during the roller embossing step, with little
appreciable variation in length occurring
15 afterwards. Consequently, reciprocal embossing
(and cutting) can occur at every L interval of
sheet 40 passing by reciprocal dies 52 and 152,
so that a fully formed fuel flow field plate 1
emerges (parts 4-5 of Figure 4B and part 6 of
20 Figure 4C).

[0054] Pursuant to the method, resin curing of
fuel flow field plate 1 occurs subsequently to
the reciprocal embossing step of the method.

[0055] The present embodiment of the method
25 could, for example, be used to fabricate fluid
flow field plates with the following geometric
characteristics (see Figures 1B and 2A for
illustrations of characteristics):

(a) Fuel flow field plate 1:

- Header region lengths L_{10} and L_{30} :
60-80 mm range;
- Fuel flow field channel region
length L_{20} : 500-700 mm range;
- Fuel flow field plate length $L_{10} +$
 $L_{20} + L_{30}$: 620-860 mm range;
- Fuel flow field widths W_{10} , W_{20} and
 W_{30} : 50-65 mm range;
- Fuel flow field thickness T_{10} , T_{20}
and T_{30} : 0.8-1.3 mm range;
- Pitch P_{22} and P_{26} : 1.1-1.6 mm range;
- Fuel flow channel width W_{22} : 0.8-
1.3 mm range;
- Coolant channel width W_{26} : 0.6-1.1
mm range.

(b) Oxidant flow field plate 6:

- Header region lengths L_{10} and L_{30} :
60-80 mm range;
- Oxidant flow field channel region
length L_{20} : 500-700 mm range;
- Oxidant flow field plate length L_{10}
 $+ L_{20} + L_{30}$: 620-860 mm range;
- Oxidant flow field widths W_{10} , W_{20}
and W_{30} : 50-65 mm range;
- Oxidant flow field thickness T_{10} ,
 T_{20} and T_{30} : 0.6-1.1 mm range;
- Pitch P_{62} : 1.1-1.6 mm range;
- Oxidant channel width W_{62} : 0.6-1.1
mm range.

[0056] Although the present method has been described by way of specific embodiment(s) for purposes of illustration, it will be appreciated that various modifications can be made without
5 deviating from the scope of the present method. For example, a fluid flow field plate can be fabricated pursuant to the method in which widths W_{10} and W_{30} are not approximately equal to fluid flow field channel region width W_{20} .

10 [0057] Figure 5A shows a fluid flow field plate where the width of header regions 10-2 and 30-2 exceed the width of fluid flow field channel region 20-2. In this case, the dual-roller embossing apparatus could be adapted so that
15 sheet 40 is embossed to outer width W_{out} . After embossing of header regions 10-2 and 30-2 has been performed, cutting step(s) could be added to narrow down the fluid flow field plate to its desired profile (that is, narrow down fuel flow
20 field channel region 20-2 width to W_{20} and narrow down parts of header regions 10-2 and 10-3 to their desired width profile).

[0058] Figure 5B shows a fluid flow field plate in which the width of header regions 10-3
25 and 30-3 is less than the width of fluid flow field channel region 20-3. In this case, the dual-roller embossing apparatus could again be adapted so that sheet 40 is embossed to outer width W_{out} . After embossing of header regions 10-
30 3 and 30-3 has occurred, cutting step(s) could be

added to narrow down the fluid flow field plate
to its desired profile, in this case to narrow
down header regions 10-3 and 30-3 to their
desired width profile (fuel flow field channel
5 region 20-3 width being already at W_{20}).

[0059] Figure 5C shows a fluid flow field
plate in which header regions 10-4 and/or 30-4
are offset with respect to fluid flow field
channel region 20-4. In such a case, the dual-
10 roller embossing apparatus could again be adapted
so that sheet 40 is embossed to outer width W_{out} .
After embossing of header regions 10-4 and 30-4
has been performed, cutting step(s) could be
added to narrow down the fluid flow field plate
15 to its desired profile (that is, narrow down one
side of fluid flow field channel region width to
 W_{20} and narrow down parts of header regions 10-4
and 10-4 to their desired profile).

[0060] As shown in Figure 5D, the present
20 method is not limited to fabricating fluid flow
field plates end to end. Fluid flow field plates
can also be fabricated side by side pursuant to
the present method (in the example shown in
Figure 5D, a number of fluid flow field plates in
25 which the header regions are offset with respect
to the fluid flow field channel regions are
fabricated side by side). In this case, the
dual-roller embossing apparatus could again be
adapted so that sheet 40 is embossed to outer
30 width W_{out} . After embossing of header regions 10-

5 and 30-5 has occurred, cutting step(s) could separate the fluid flow field plates from one another and narrow the plates down to their desired profile.

5 [0061] It is also possible, pursuant to the method, to fabricate fluid flow field plates such as oxidant flow field plate 6. In such an example, roller 41B would have no teeth, as no channels are needed on non-active surface 67 (as
10 seen in Figure 1A).

[0062] Fluid flow field plates can also be fabricated pursuant to the present method in which fluid distribution region(s) are positioned elsewhere than at a fluid flow field plate's
15 extremities. For example, Figure 6 shows an intermediate flow distribution region 60. In this case, further reciprocal dies could be used to emboss region 60 at the proper location after the roller embossing step. Other types of non-
20 flow field channel region(s), such as an intermediate region allowing for the passage of fuel cell stack compression means (for example, tie rods), could also be reciprocally embossed pursuant to this method.

25 [0063] While particular elements, embodiments and applications of the present method and apparatus have been shown and described herein, it will be understood, of course, that the invention is not limited thereto since
30 modifications may be made by those skilled in the

art, particularly in light of the foregoing
teachings. It is therefore contemplated by the
appended claims to cover such modifications as
incorporate those features that come within the
5 scope of the invention.